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Superposition of Earthquake Cycle and Long-term Tectonic Deformation Signals in Plate Boundary Transition Zones

Kevin P. Furlong (1), Kirsty A. McKenzie (1), and Matthew W. Herman (2)

(1) Penn State University, Department of Geosciences, University Park, PA, United States (kevin@geodyn.psu.edu), (2) Utrecht University, Department of Earth Sciences, Utrecht, Netherlands

Observations of crustal deformation provide some of the most useful data for constraining the earthquake cycle along plate boundaries. If however there are multiple tectonic processes occurring in the region, our observations will reflect a superposition of the effects of all processes producing near-surface deformation. In particular there can be the combination of earthquake cycle (short-term) and 'permanent' crustal deformation (long-term) contributions to the observed geodetic signal. Understanding this effect is particularly important in plate boundary transitions, such as triple junction regions where the deformational style changes over relatively short distances. An example from the Mendocino triple junction region (MTJ) in northern California, where there is an abrupt change from subduction to translation, shows the effects of superimposing megathrust earthquake cycle signals with transform shear strain and crustal shortening associated with the northern termination of the adjacent San Andreas plate boundary. By combining geodetic (GPS, leveling), geologic (uplift/exhumation rates), and seismological (crustal structure evolution, heat flow) we are able to isolate the three components to the observed deformational signal - the megathrust EQ cycle (short-term), San Andreas shear EQ cycle (short-term), and MTJ crustal shortening (long-term). It is only through an understanding of the integration of the range of tectonic processes and their associated deformational signals that combine to produce the observations that we can isolate each process. In addition to triple junctions where such effects are common, regions of plate boundary transitions such as in northern South Island New Zealand (subduction to transpression) also reflect this superposition of tectonic signals generated by processes with different time-scales.